



Standard Guide for Defining and Rating the Microstructure of High Carbon Bearing Steels¹

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^{ε1} NOTE—Units statement was inserted in Section 1.5 editorially in October 2014.

1. Scope

1.1 This guide covers the description of carbide structures in annealed high carbon bearing steels.

1.2 Included is a guide for rating steel specimens by a graded series of photomicrographs showing the incidence of certain conditions.

1.3 The reference photomicrographs are graded illustrations of annealed carbides categorized by size, network, and lamellar content (shape).

1.4 This guide is to facilitate communication and description of microstructure. It does not establish limits of acceptability. Such limits are a matter of agreement between user and producer.

1.5 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.6 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:²

E3 Guide for Preparation of Metallographic Specimens

E407 Practice for Microetching Metals and Alloys

E1245 Practice for Determining the Inclusion or Second-Phase Constituent Content of Metals by Automatic Image Analysis

¹ This guide is under the jurisdiction of Committee A01 on Steel, Stainless Steel and Related Alloys and is the direct responsibility of Subcommittee A01.28 on Bearing Steels.

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² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

2.2 ASTM Adjuncts:

Photomicrographs for Defining and Rating the Microstructure of High Carbon Bearing Steels³

3. Apparatus

3.1 In order to adequately compare the structure of a specimen with the photomicrographs, it will be necessary to view a properly prepared sample at 1000× magnification with good resolution.

4. Specimen Preparation

4.1 Samples that represent a portion of the cross section of the material shall be prepared using the practices described in Guide E3. The size of the sample shall be negotiated between the user and the producer. It may be a full cross section but should not be too large for practical handling in the polishing operation.

4.2 The properly polished specimens shall be etched in a suitable etchant which will clearly delineate the annealed carbide structure of the material being examined as described in Practice E407. Nital (2 %) will frequently be an adequate etchant for routine examination. When critical or detailed analysis of structures is required, the recommended etchant is Picral (saturated).

5. Description

5.1 The reference photomicrographs (available in ASTM Adjunct ADJA0892³) are arranged into three categories, as follows: carbide size (CS), carbide network (CN), and lamellar content (LC).

5.2 Six photomicrographs for each category are provided and are identified by category and number, for example, CS1-CS6, CN1-CN6, and LC1-LC6. Higher numbers indicate a larger number or greater degree of severity of the category being rated.

³ Available from ASTM International Headquarters. Order Adjunct No. ADJA0892. Original adjunct produced in 2009.

5.2.1 Actual counted number of carbides per 400 μm^2 determined from the carbide size series of photomicrographs is as follows (reported counts are the average of three measurements):

CS1 508
CS2 419
CS3 324
CS4 234
CS5 165
CS6 115

6. Procedure for Evaluation

6.1 Using an optical metallograph and a magnification of 1000 \times , examine a properly prepared and etched specimen. Select a field which is representative of the category to be graded and compare it to the photomicrographs which are part of this method. The rating will be the number of that photo that most closely resembles the appearance of the specimen. A

separate field may be used for each category or a single field may be rated for more than one category. An example rating is CS4, CN2, LC1.

6.2 As an alternate method, the rating of carbide size by automatic image analysis shall be conducted in accordance with Practice E1245. The rating shall be defined by the following equation:

$$\text{Rating} = 6.7888 - 4.5924 (10^{-6}) * n_A \quad (1)$$

where:

n_A = number of carbides per mm^2 .

The results shall be rounded to the nearest integer value from 1 to 6.

7. Keywords

7.1 antifriction bearings; bearing steel; chromium alloy steel; metallography

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